

Lessons Learnt Report #3

2021/ARP009 Ground Source Systems Pty Ltd
Yanderra Shallow Geothermal Solar System



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1. Project Details

Project Title	Ground Source Systems Yanderra Shallow Geothermal-Solar Systems Demonstration
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The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

2. Executive Summary

Ground Source Systems Pty Ltd has built and is now operating a hybrid geothermal system for heating and cooling a commercial poultry breeding facility in Yanderra, NSW to demonstrate its effectiveness and its financial & environmental benefits to the rural industries. The hybrid geothermal system comprises a ground-source heat pump (GSHP) system in part fed by a solar PV, and with gas back-up. A GSHP system has been installed to replace in full or in part LPG (Liquefied Petroleum Gas) as a fuel for heating and evaporative cooling for a single poultry shed. The typical mid-sized poultry operation at the Yanderra demonstration site is providing an important case study to drive uptake across the sector.

Contracts were signed between November 2021 and February 2022, with the geothermal-solar system becoming operational by September 2022, ahead of the planned November 2022 start to be able to capture some of the winter batches that require most heating. The system construction was largely completed during the previous reporting period. Two batches of birds were acclimatized with the geothermal-solar system during this reporting period: i) March-April 2023 – for 5 weeks and ii) May-June 2023 for almost 4 weeks. This lessons learnt report focuses on the lessons gained through the data collection, the operation of the re-designed distribution system, contracting and control for this project. Specific technical and heating performance lessons learnt on this project are shared in this report.

The lessons learnt explored in this report focus on four key learnings:

- There is still a lack of market maturity for shallow geothermal projects in the agriculture sector, however this is changing with increasing number of enquiries about this project and the technology, from potential users to local and international designers and installers, and a few media outlets arising from this project and word of mouth. Particularly, there is limited depth of ground source heat pump designers and providers in Australia able to demonstrate a comprehensive understanding of the specific needs of the poultry industry.
- The challenge posed by dust in sheds was overcome through additional efforts and investment led by the Recipient and its efficacy further proving during this period. Pressure on filters may need adjustment depending on stiffness of air filters.
- Gas as source of heat fuel (or any other) can be replaced in its entirety with GSHP heating, and the operational cost is so low in comparison with traditional fuels that heating can run for longer to achieve greater wellbeing (and possibly yield) of birds.
- Data analysis points to coefficients of performance of up to 5, with averages above approximately 3.5, meaning up to 5 kWh of thermal energy obtained for each kWh of electricity input into the GSHPs. This is better than expected and points to very competitive running costs and lower carbon emission equivalent. Greater details are expected in the next and final report. Note that in this “retrofit” project, commercial operation of the poultry sheds continues alongside any works required.

3. Project Overview and Progress

The overall purpose of the project is to demonstrate a hybrid geothermal system for heating and cooling a commercial poultry breeding facility in Yanderra, NSW. The hybrid geothermal system comprises a ground-source heat pump (GSHP) system in part fed by a solar PV, and with gas back-up. A GSHP system has been installed to replace in full or in part LPG (Liquefied Petroleum Gas) as a fuel for heating and evaporative cooling for a single poultry shed. The typical mid-sized poultry operation at the Yanderra demonstration site is providing an important case study to drive uptake across the sector.

We are happy to report that the construction of the hybrid ground source heat pump system has been completed, and the system (ground loops, plant, fancoil units, solar PV) is operational and commissioned, with a pre-commissioning run in September 2022 (bird Batch no. 1) and a commissioning run in November 2022 (bird Batch no. 2), and for this reporting period, a run in March-April 2023 (bird Batch no. 3) and in May-June 2023 (bird Batch no. 4). The plant, which contains mainly heat pumps, valving, circulation pumps, buffer tanks and control systems, is located just outside the demonstration shed. A shipping container was used to house them. Inside the chicken sheds, fancoil units are inter-connected to buffer tanks in the plant to deliver heating to the shed. In this period, some maintenance and future optimisation strategies were discussed, data were collected and analysed. Mislabelling and malfunctioning sensors and transducers are being identified.

Sensors were tidied up and finally commissioned during this time, however through the analysis of data we observed that automated datalogging requires further refinement and calibration rectification. Note that the system contains many more sensors and transducers than a normal commercial system to facilitate quantification of performance and savings for this demonstration project. The system is logging over 100 points every 15 minutes.

Through data analysis by the University of Melbourne's experts, we are thrilled to report that even without optimisation, coefficients of performance (COPs) of up to 5 were achieved (meaning for each kWh of electrical power fed into the heat pumps, up to 5 kWh of thermal energy were obtained). This translates into **low running costs and carbon emissions of the system**. With averages above 3.5, this observed performance is better than expected considering i) the peak of winter approaching and ii) that the ground loops were installed in a configuration that was more compacted than designed for due to ground conditions encountered during construction (and previously reported). Note that as agreed with ARENA and the farmer, the shed continued its normal commercial operation while all these project's works were underway.

The operation of the commissioned system in the 3rd and 4th batches of birds in this project allowed capturing some key data to start reporting meaningful technical metrics and set the bases for the financial, economic, and environmental benefit implications of the system to poultry farms. Importantly, gas savings of up to 100% were demonstrated with respect to control sheds during the 3rd batch of birds in this reporting period. Further optimisation may be still possible.

The project continued to attract significant media and rural & poultry industry interest, deriving in more than a dozen articles, both nationally and internationally plus several twitter and LinkedIn stories and re-posts, and presentations to industry. A public lecture about the project at The University of Melbourne and to AREEA (Australasian Renewable Earth Energy Association) is expected in the second half of 2023.

Ground Source Systems was distinguished with an **Australian Enterprise Award (2023) for "Best Farm Heating Solutions Provider 2023"** during this reporting period. This suggests the project is going in the right direction and others are noticing.

Overall, the project is largely on track and on schedule at this stage, but with some (expected) sensor malfunctioning (thus a maintenance budget) and mislabelling detected during data reduction and analysis. These has not impacted on reported values, and results are clearly demonstrating it can displace gas, render high coefficients of performance and more uniform distribution of heating in the sheds.

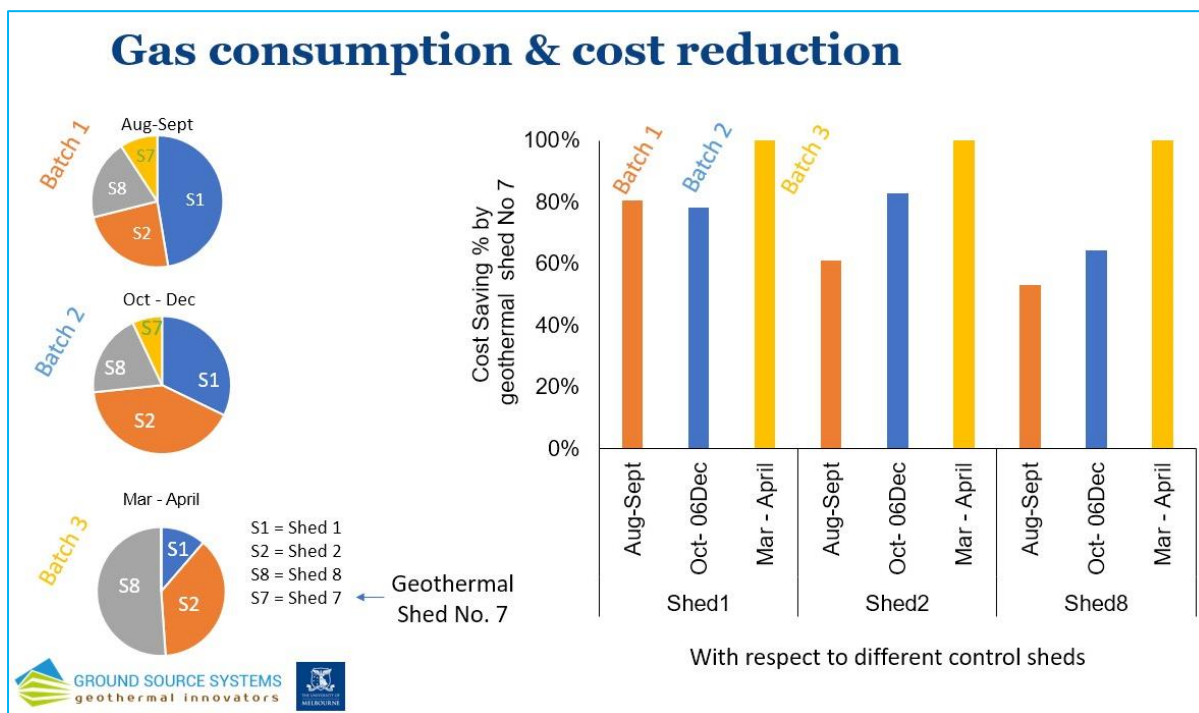


Figure 1. Measured gas consumption for heating in the demonstration geothermal shed (No. 7) in comparison with three other control sheds (Nos. 1, 2 and 8) in the same Yanderra farm. Gas can be completely eliminated for heating poultry sheds.

4. Key Learnings

4.1 Lesson learnt No. 1: It takes more than one or two GSHP providers to grow and drive market maturity for shallow geothermal projects in the agriculture sector

Category: Commercial

Objective: Improving understanding of agriculture market needs, supply chains and collaborations

Detail: While GSHP-solar technology is steady growing in Australia in the high end residential sector and some commercial sector, and significant advances have been made in increasing awareness amongst stakeholders thanks to this project and media and technical posts, market penetration in the agriculture sector is still challenging. Ground Source Systems Pty Ltd is proactively pursuing customers and has received a number of enquiries, a portion of which from overseas.. A comprehensive understanding of the specific needs of the poultry industry is needed amongst more GSHP-solar suppliers, particularly from engineers and installers, to help drive uptake.

In addition to design, large earthwork contractors in rural settings are limited, with additional pressures nationwide from large infrastructure, and construction projects in metropolitan Melbourne and Sydney.

Implications for future projects:

Ground Source Systems expects this situation will change over time as additional GSHP suppliers in the chain enter the Australian (agriculture) market and expertise develops for suppliers. The press releases and media outlets continue to generated movement and enquiries from all sectors (from engineering to prospective clients). Future projects will be able to leverage the learnings and market developments that this project has enabled. New partnerships with smaller drilling / earthwork or civil contractors and with industry associations, such as AREEA, IGSHPA or AIRAH, may be needed to accelerate growth and mature the market.

4.2 Lesson learnt No. 2: Dust in sheds reduces fan coil unit efficiency over time, automated cleaning systems required to maintain performance

Category: Technical and Commercial

Objective: Improving customer experience and minimizing maintenance labour

Detail: The operation of the pre-commissioned system in the September 2022 batch of birds showed the importance of keeping fan coil units and filters clean for optimal operation. A technical solution (beside manual cleaning) was found thanks to additional efforts. This works fell outside the original scope of works of this ARENA project. The final solution involves both modifications to fan coil units, operational programming, and know-how from the participant.

Left untreated, fan coil unit filter clogging reduces and even stops heat delivery to the shed. The system may become non-operational within days since the heat in the coils cannot be dissipated and the GSHP soft lock is triggered. Importantly, chicks do not receive the amount of heat they need. While specific tests and monitoring were not carried out to measure performance decline due to dust, performance and operability was observed to be lost quickly, within days, without such cleaning.

Implications for future projects:

Fan coil units will be equipped with automated cleaning system, controls and installation costing will be built-in. This will avoid or largely minimise maintenance of the units while maintaining high performance over time.

4.3 Lesson learnt No. 3: Gas as heat fuel source can be completely displaced

Category: Commercial, technical, and environmental

Objective: Reducing running costs and carbon emissions

Detail: The operation of the commissioned system in the 3rd and 4th batches of birds in this project allowed capturing some key data to start reporting meaningful technical metrics and set the bases for the financial, economic, and environmental benefit implications of the system to poultry farms. Importantly, gas savings of up to 100% were demonstrated with respect to control sheds during the 3rd batch of birds in this reporting period (see Figure 1).

Implications for future projects:

Installation of the geothermal-solar systems can completely electricity heating and cooling systems, should farmers and operators desire to do so. Offering options of geothermal-solar system that can displace most, but not all use of gas heaters may be able to lower capital costs, and offer an additional back up to the geothermal-solar system for new builds. This may drive buy-in by farms. Retrofit jobs can keep gas heaters for the same reasons.

4.4 Lesson learnt No. 4: High efficiency can be achieved and there is room to lower capital costs

Category: Commercial

Objective: Reducing installation costs and carbon emissions

Detail: Through data analysis by the University of Melbourne's experts, coefficients of performance (COPs) of up to 5 were achieved. This translates into low running costs and carbon emissions of the system, but also demonstrates that ground loops, an important component of capital costs, can be reduced in size, at the expenses of lower COPs (and thus slightly higher running costs).

Implications for future projects:

Choice of sizes and estimated capital and running cost (life cycle costs) shall be presented to clients to make the ultimate decision and balance capital vs running costs savings. Data to date shows a larger system would be beneficial in the long run. Banks may need to be involved to finance capital expenditure to maximise benefits to farms.